US007872779B2

(12) **United States Patent**
Nagatani

(10) **Patent No.: US 7,872,779 B2**
(45) **Date of Patent: Jan. 18, 2011**

(54) **IMAGE READING APPARATUS INCLUDING DRIVING MODULE**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1169 days.

(21) Appl. No.: **11/470,442**

(22) Filed: **Sep. 6, 2006**

(65) **Prior Publication Data**

US 2007/0109562 A1 May 17, 2007

(30) **Foreign Application Priority Data**

Nov. 12, 2005 (KR) 10-2005-0108300

(51) **Int. Cl.**
H04N 1/04 (2006.01)

(52) **U.S. Cl.** **358/474**; 358/497; 358/509; 358/475; 399/212; 271/10.11; 347/104

(58) **Field of Classification Search** 358/474, 358/497, 496, 475, 509, 486; 347/104, 37, 347/197, 176; 271/10.11, 9.08, 164, 9.11; 399/212, 377
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,155,641	A *	5/1979	Sagara et al.	399/212
4,158,499	A *	6/1979	Hattori et al.	399/210
4,600,293	A *	7/1986	Watanabe	399/14
4,636,058	A *	1/1987	Fujii	399/212
4,879,604	A *	11/1989	Koshiyouji	358/474
4,891,669	A *	1/1990	Hiroki	399/118
4,893,196	A *	1/1990	Koshiyouji et al.	358/474
5,997,129	A *	12/1999	Matsuhashi	347/35
2002/0109864	A1 *	8/2002	Nishikino et al.	358/418
2003/0184818	A1 *	10/2003	Mikajiri et al.	358/474
2006/0240924	A1 *	10/2006	Osakabe et al.	474/117
2007/0047025	A1 *	3/2007	Fujioka et al.	358/474
2007/0154241	A1 *	7/2007	Maruno	399/211

FOREIGN PATENT DOCUMENTS

CN	1288167 A	3/2001
JP	05-191584	7/1993
JP	2001-358912	12/2001
JP	2002-328437	11/2002
KR	1998-53447	9/1998

OTHER PUBLICATIONS

Chinese Office Action dated Dec. 14, 2007 issued in CN 200610154277.5.

* cited by examiner

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(57) **ABSTRACT**

An image reading apparatus includes an image sensor fixed to a main body of the image reading apparatus, a light scanning carriage, a light reflection carriage, a pair of transport modules to move the light scanning carriage and the light reflection carriage in a sub-scanning direction with a predetermined speed ratio, and a wire having both ends fixed to the main body of the image reading apparatus and a portion fixed to the light scanning carriage, the wire wound around carriage pulleys of the light reflection carriage and fixing pulleys of the main body. Therefore, an accuracy of a moving of the carriages is improved, thus preventing a defective reading operation. Manufacturing costs of the image reading apparatus are reduced.

29 Claims, 9 Drawing Sheets

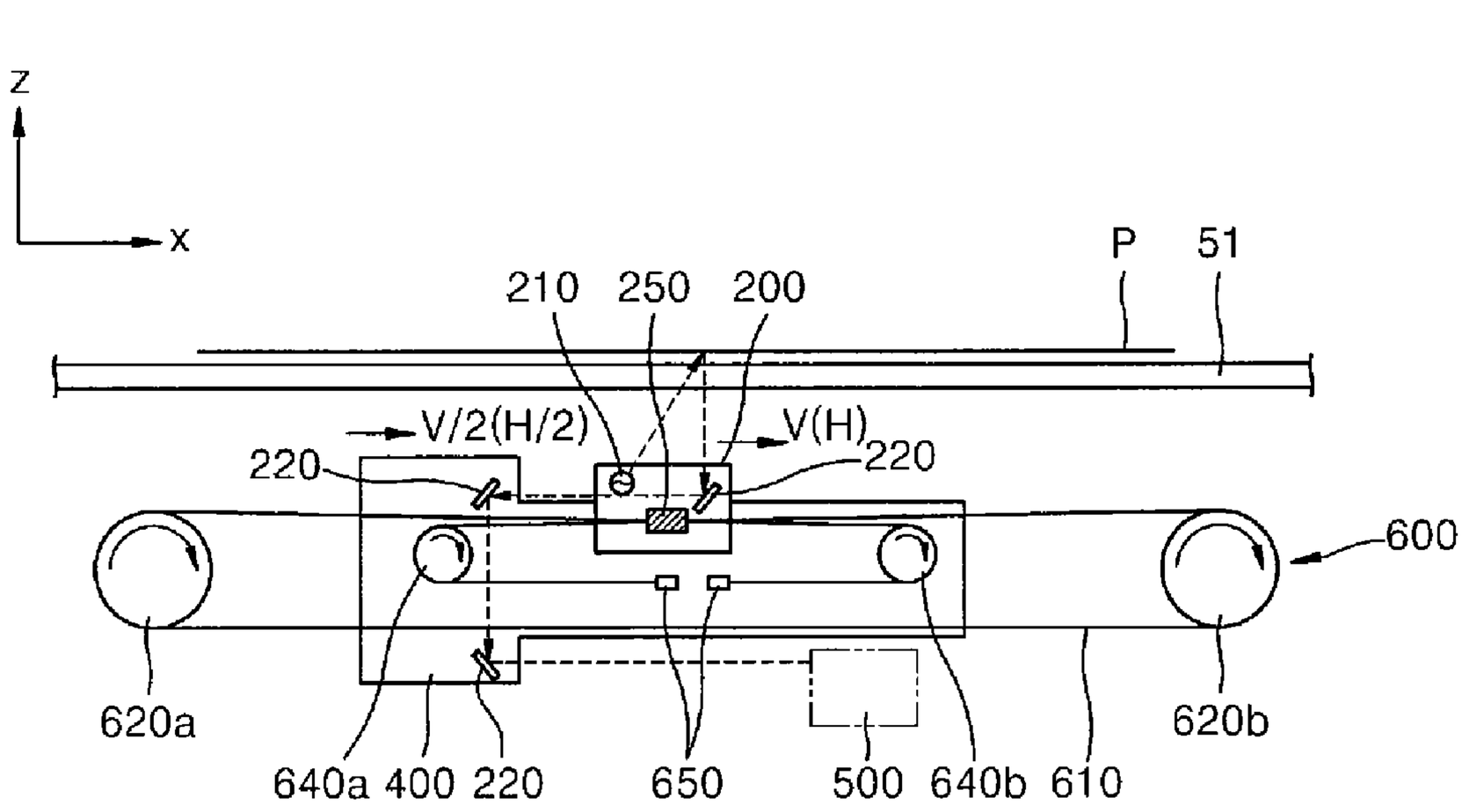

FIG. 1 (PRIOR ART)

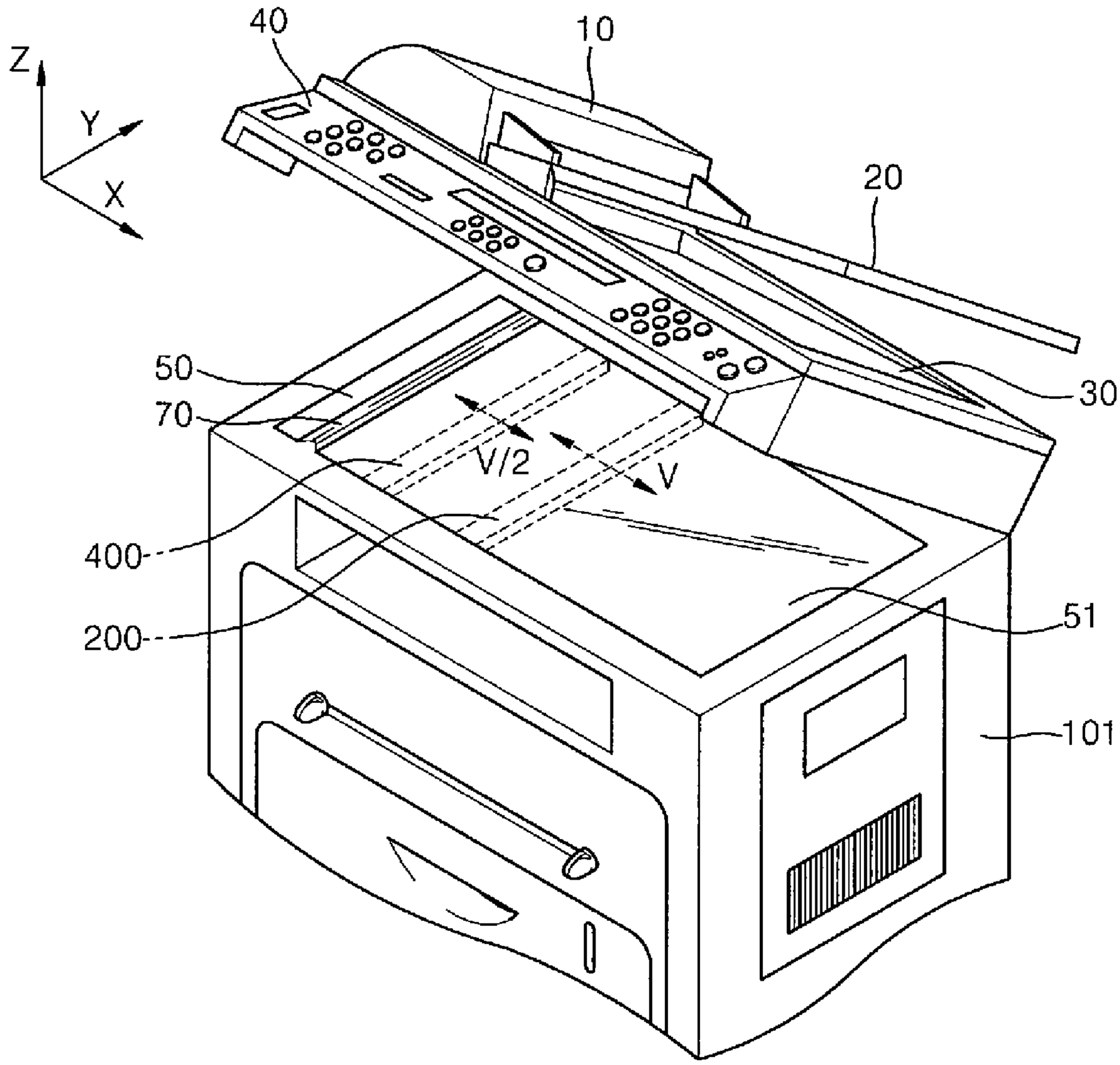

FIG. 2

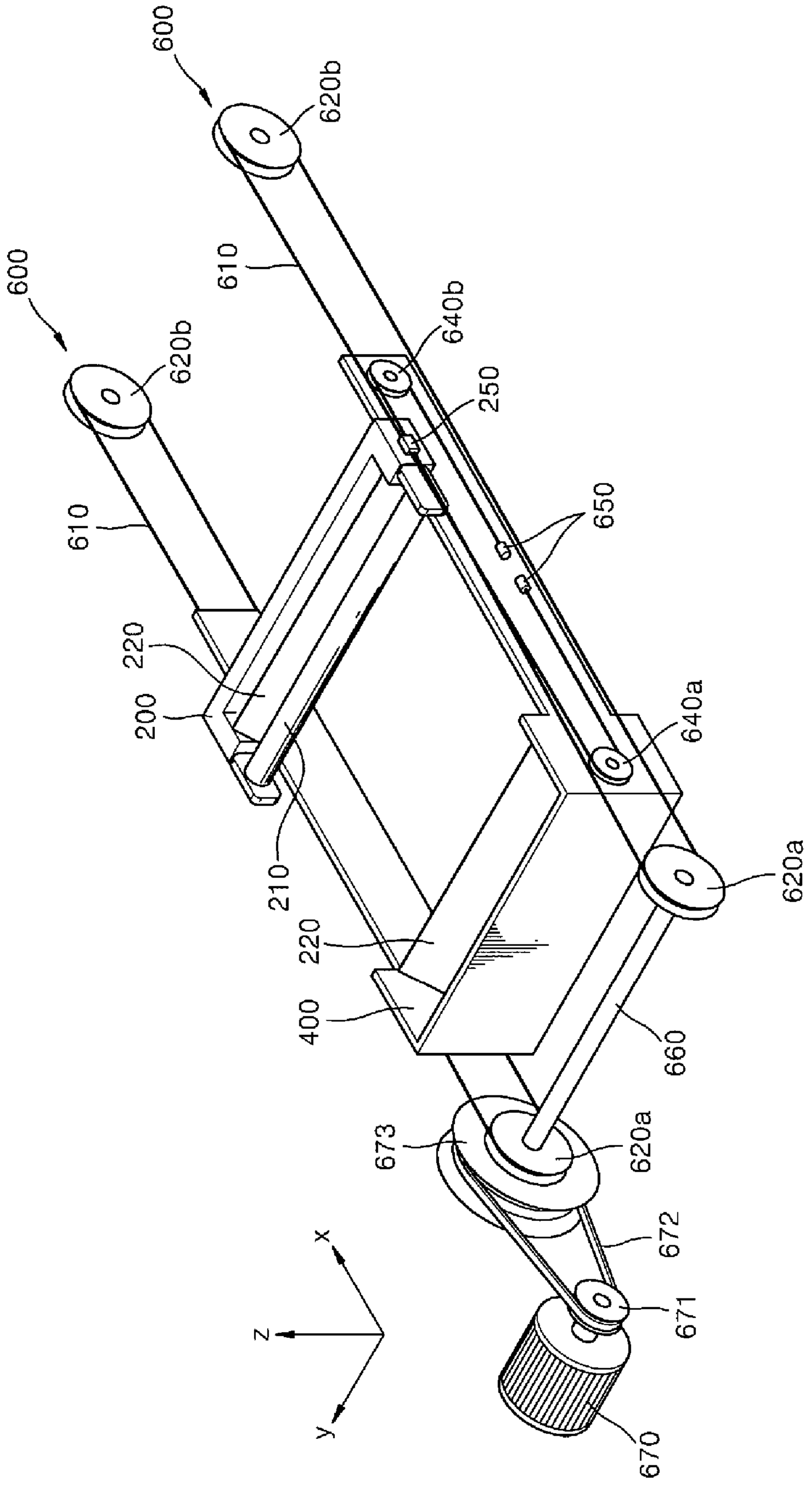
600
620b
610
640b
250
650
600
620b
610
220
200
210
220
400
640a
620a
660
673
620a
672
671
670
x
z
y

FIG. 3

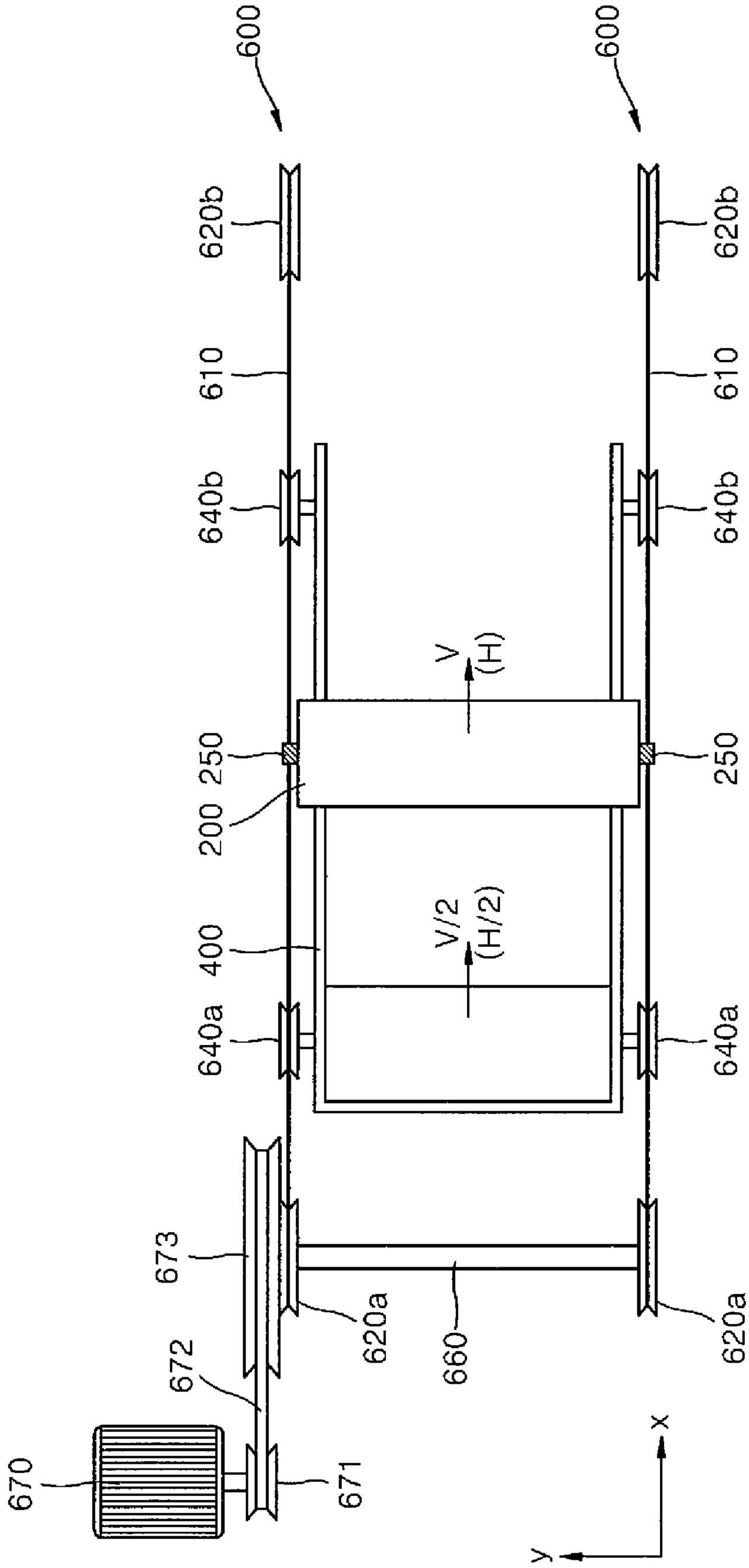
600
620b
610
640b
V
(H)
250
200
400
V/2
(H/2)
640a
673
672
620a
660
670
671
x
y

FIG. 4

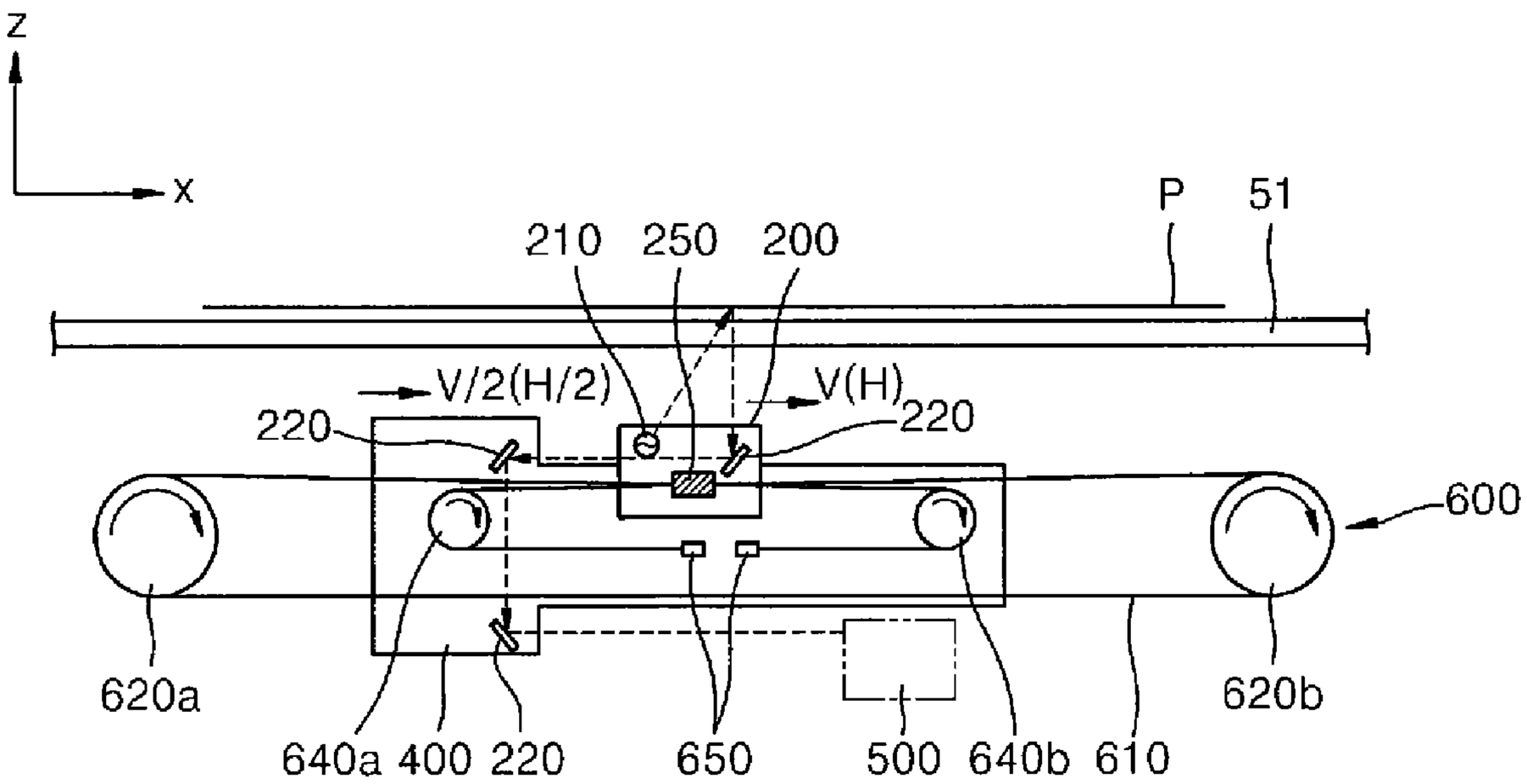
z
x
P
51
210
250
200
V/2(H/2)
V(H)
220
220
600
620a
620b
640a
400
220
650
500
640b
610

FIG. 5

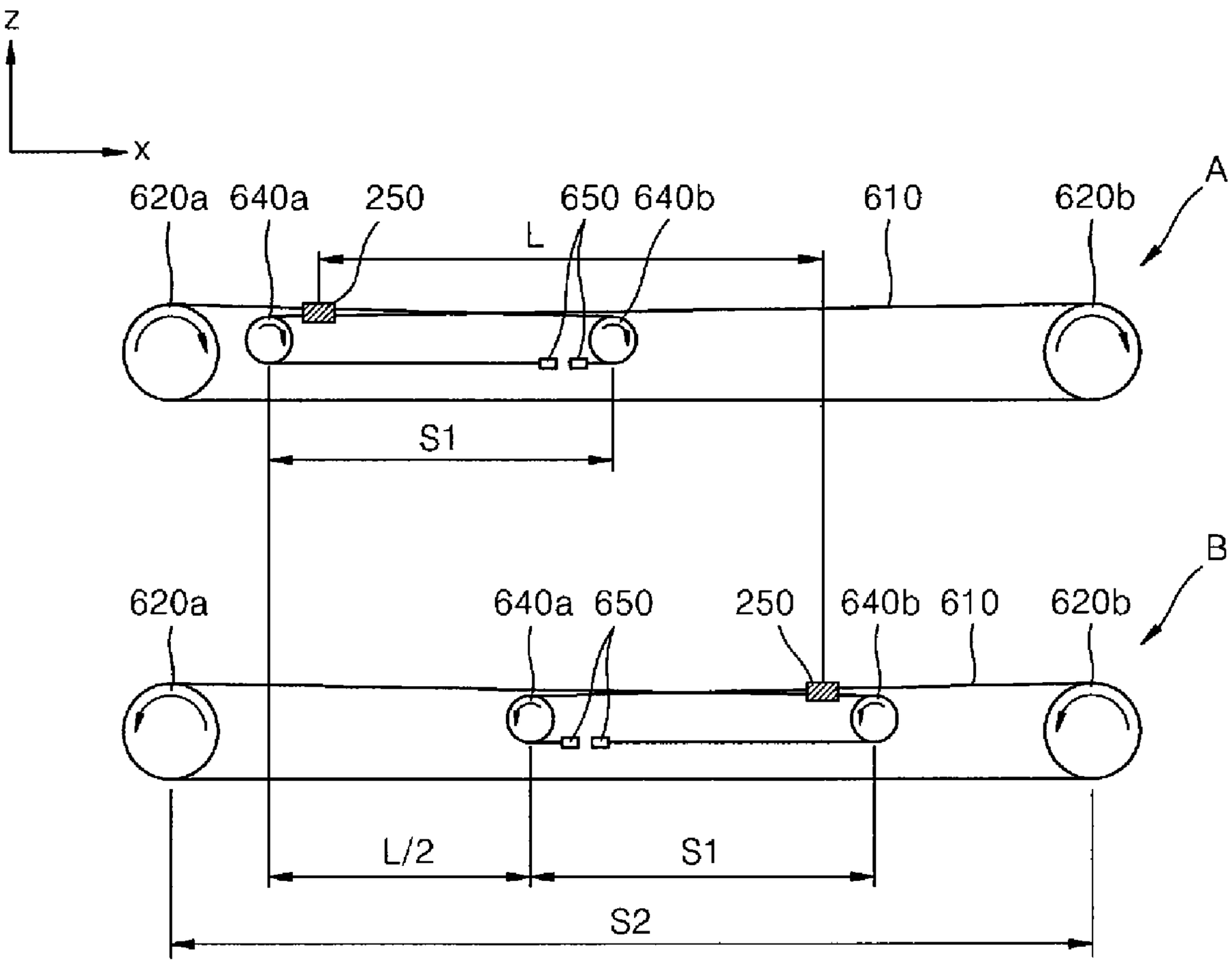
Z
X
620a
640a
250
650
640b
610
620b
A
L
S1
620a
640a
650
250
640b
610
620b
B
L/2
S1
S2

FIG. 6

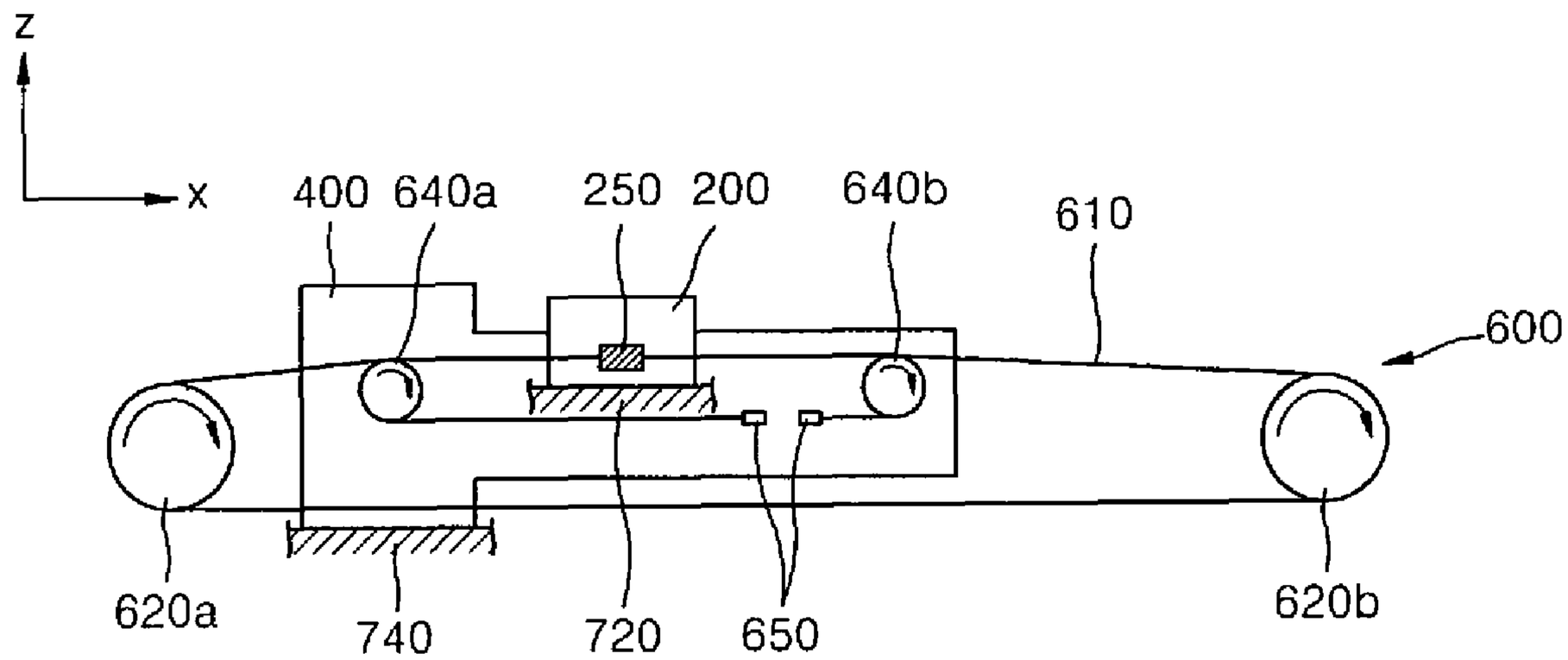

FIG. 7

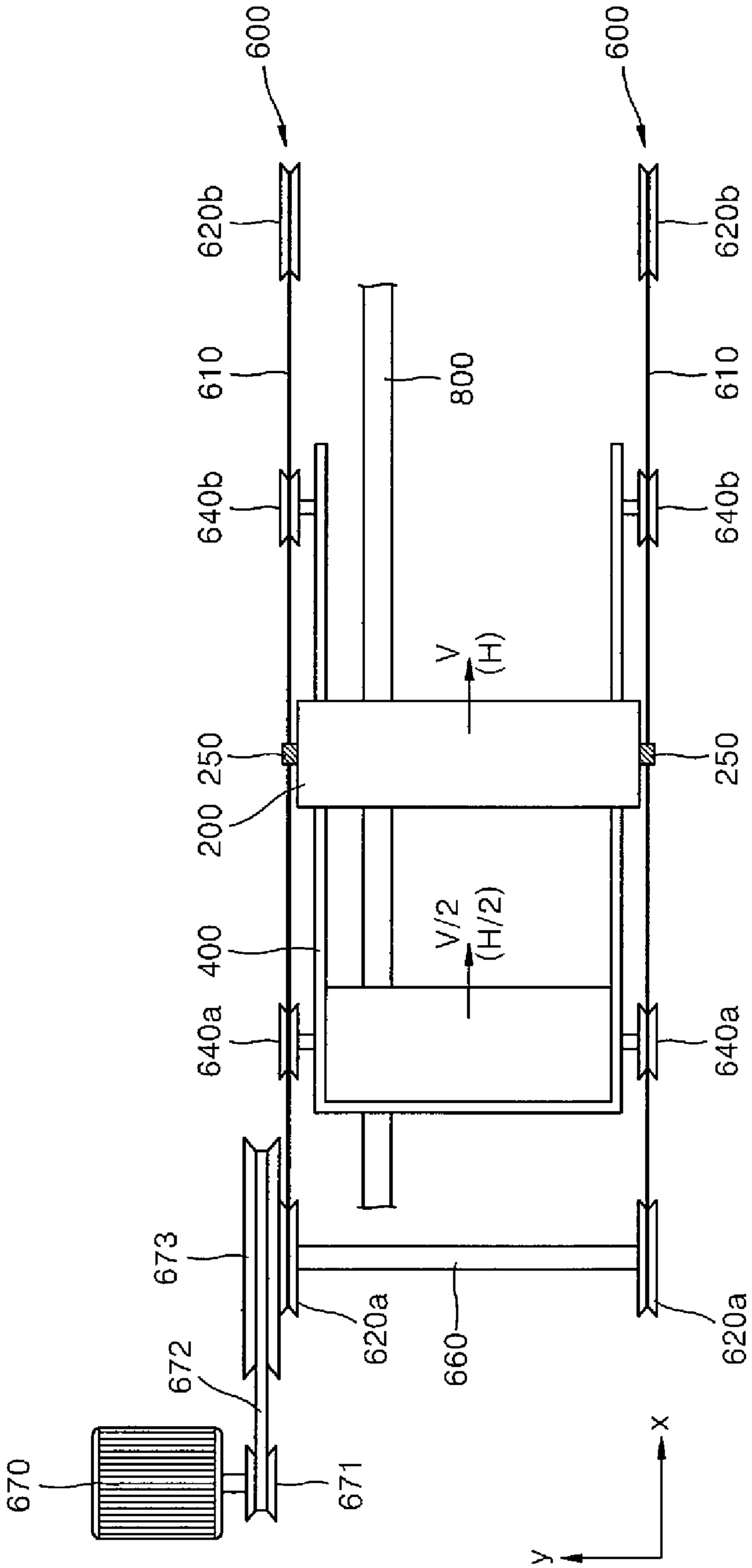
600
620b
610
800
640b
V
(H)
200
250
400
V/2
(H/2)
640a
673
672
620a
660
670
671
x
y

FIG. 8

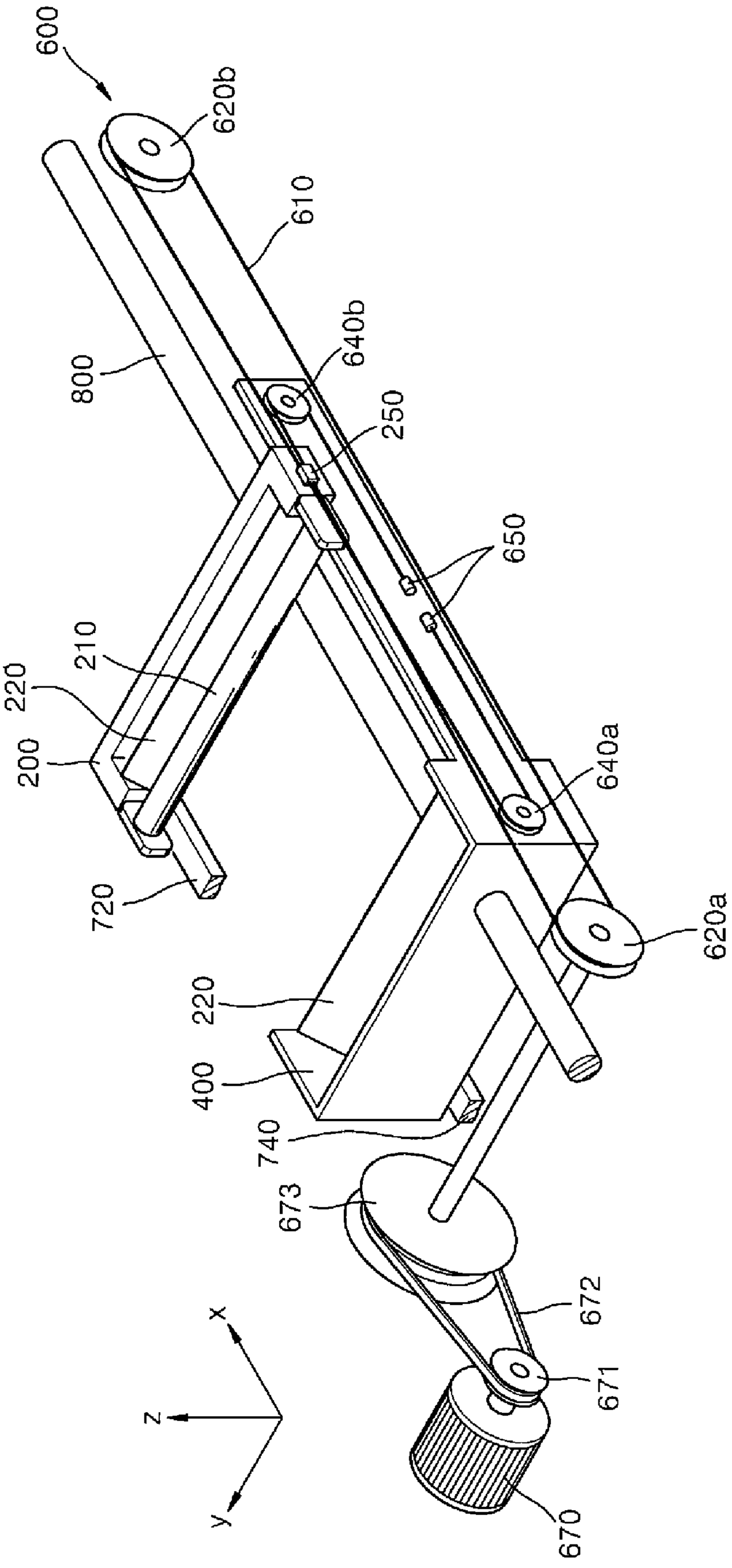
600
620b
610
640b
800
250
650
210
220
200
640a
720
620a
220
400
740
673
672
671
670
x
z
y

FIG. 9

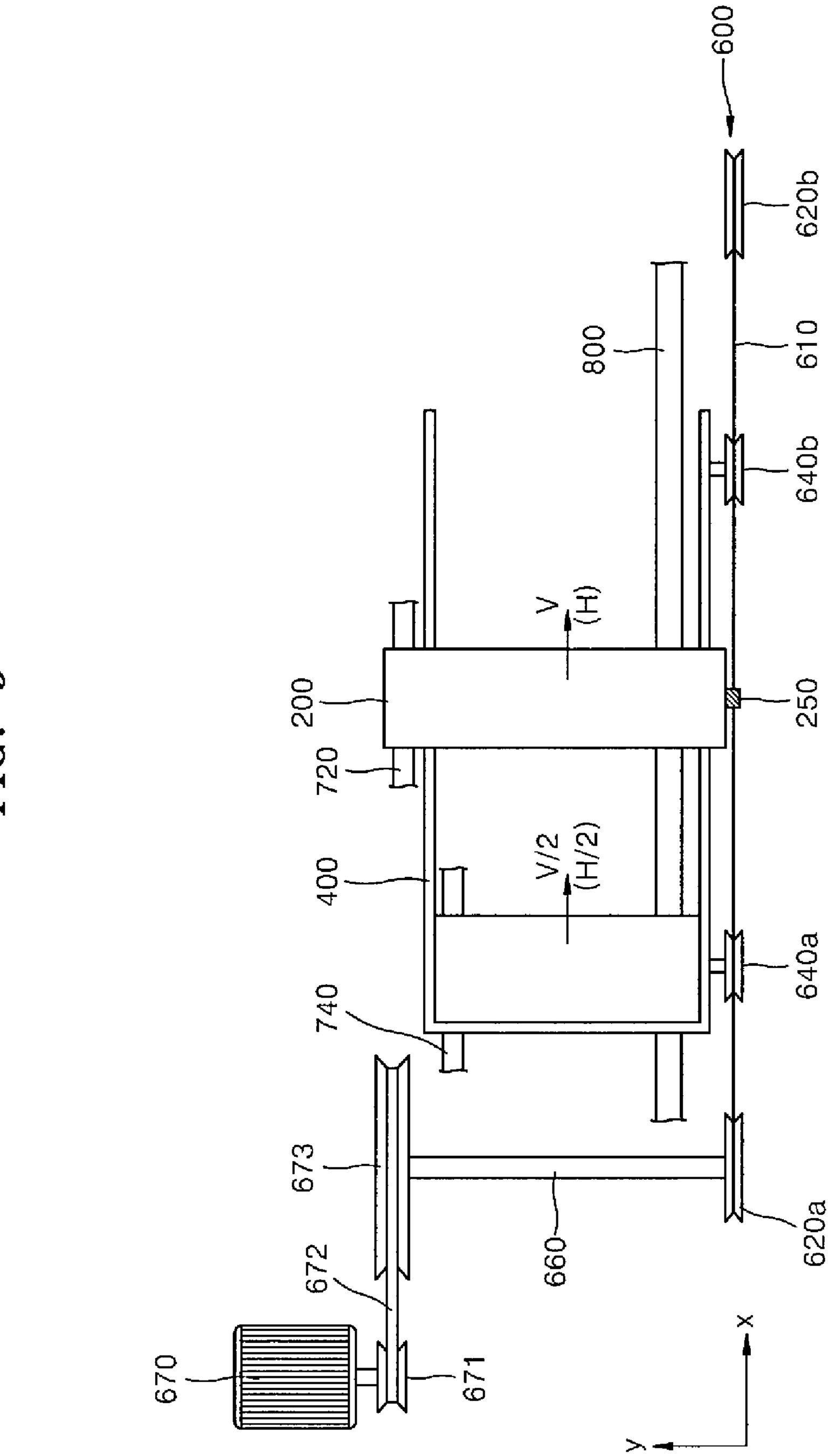
600
620b
800
610
640b
V
(H)
200
250
720
V/2
(H/2)
400
640a
740
673
660
620a
672
670
671
x
y

IMAGE READING APPARATUS INCLUDING DRIVING MODULE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the priority of Korean Patent Application No. 10-2005-0108300, filed on Nov. 12, 2005, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein in its entirety by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present general inventive concept relates to an image reading apparatus, and more particularly, to an image reading apparatus in which an image sensor is fixed to a main body of the image reading apparatus and a light scanning carriage that scans a laser onto a document and a light reflection carriage that reflects a light signal to the image sensor are separately moved.

2. Description of the Related Art

Image reading apparatuses scan a laser beam onto a document to read an image printed on a document. Scanners, facsimiles, and multi-function peripherals are examples of the image reading apparatuses.

In order to read the image of the document, a scanning module should move, or the document should be moved. Flat-bed type image reading apparatuses are a type of the image reading apparatus in which the scanning module moves. Sheet-feed type image reading apparatuses are a type of the image reading apparatus in which the document moves. The flat-bed type image reading apparatuses that include an automatic document feeder (ADF) can also perform as the sheet-feed type image reading apparatuses.

The image reading apparatus includes a glass plate on which the document is placed, and the scanning module below the glass plate. The scanning module includes a light scanning carriage scanning light onto the document, an image sensor converting a light signal obtained by reading the document into an electric signal, and a light reflection carriage reflecting the light signal to the image sensor.

The light scanning carriage includes a light source below the glass plate for scanning the light onto the document. For example, the light source can be a halogen lamp having a predetermined length along a main scanning direction of the document, and scans the light along the entire main scanning direction at one time.

The image sensor includes a charge-coupled device (CCD) sensor, a control board controlling the operation of the CCD sensor, and a lens unit focusing light signals onto the CCD sensor.

The light reflection carriage forms an optical path from the light source to the image sensor. The light reflection carriage includes a plurality of mirrors reflecting the light signal obtained by reading the document to the image sensor.

In general, there are two types of the scanning module. One type of the scanning module is an integrated type in which the light scanning carriage, the image sensor, and the light reflection carriage are integrally installed in an outer frame of the scanning module, and the outer frame, the light scanning member, the image sensor, and the light reflection member move together along a sub-scanning direction to read the image of the document. The sub-scanning direction is perpendicular to the main scanning direction.

The second type of scanning module is a separated type, in which the light scanning carriage, the image sensor, and the light reflection carriage are separate. The image sensor is fixed to a main body of the image reading apparatus, and the light scanning carriage and the light reflection carriage move at different speeds from each other along the sub-scanning direction to maintain a total length of the optical path at a constant length. In the separated type scanning module, mass of moving parts can be lower than that in the integrated type scanning module, and thus, the module can move at a high speed. Since the image sensor is fixed to the main body of the image reading apparatus, a resolution can be improved regardless of the size and weight of the sensor. The separate type scanning module is suitable for a high end image reading apparatus that can read large-sized documents at high speed due to a lower mass of inertia of the moving parts.

In an image reading apparatus other than sheet-feed type image reading apparatus, the scanning module should move along the sub-scanning direction to read the image of a document. The image reading apparatus includes a transport module moving the scanning module in the sub-scanning direction. The separated type scanning module includes the transport module that can move the light scanning carriage and the light reflection carriage at different speeds from each other. Therefore, the total length of the optical path from the light source to the image sensor can be maintained constant.

When the size and the weight of the light scanning carriage and the light reflection carriage are increased in order to read a large-sized document, it is hard to control the positions or the velocities of the light scanning carriage and the light reflection carriage. In order to maintain the scanning time at a constant time even when the size of the document increases, the light scanning carriage and the light reflection carriage should move faster. Therefore, a transport module having high accuracy and reliability are required to move the large and heavy light scanning carriage and the light reflection carriage. In addition, when the resolution of the image sensor is high, a precise transport module is required.

The total length of the optical path can be maintained at the constant time when the position of the image sensor, the positions and angles of the mirrors, and a ratio between the velocities of the light scanning carriage and the light reflection carriage are maintained at constant velocities. However, vibrations generated when moving the light scanning carriage and the light reflection carriage, friction, and changes in a driving load may cause a jittering of the light scanning carriage and the light reflection carriage. Thus, the length of the optical path and a reading quality of the image may vary.

SUMMARY OF THE INVENTION

The present general inventive concept provides an image reading apparatus including a transport module that can maintain a fixed ratio between velocities of a light scanning carriage and a light reflection carriage so that the light scanning carriage and the light reflection carriage can have an accurate movement.

Additional aspects and advantages of the present general inventive concept will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the general inventive concept.

The foregoing and/or other aspects and utilities of the present general inventive concept may be achieved by providing an image reading apparatus including a main body, an image sensor fixed to the main body, a light scanning carriage to scan light onto a document and to reflect a light signal corresponding to scanned light after reading the document, a light reflection carriage to reflect the light signal incident

from the light scanning carriage to the image sensor, and a pair of transport modules to move the light scanning carriage and the light reflection carriage in a sub-scanning direction with a speed ratio of 2:1, the pair of the transport modules including, a first fixing pulley and a second fixing pulley connected to a driving source and separated from each other in the sub-scanning direction, a first carriage pulley and a second carriage pulley disposed on the light reflection carriage between the first and second fixing pulleys, and a wire having both ends fixed to the main body and having a portion fixed to the light scanning carriage, the wire being sequentially wound around the first carriage pulley, the second fixing pulley, the first fixing pulley, and the second carriage pulley.

The apparatus may further include, guide rails to support at least one end of each of the light scanning carriage and the light reflection carriage such that the light scanning carriage and the light reflection carriage can move.

The apparatus may further include, a guide shaft inserted into the light scanning carriage and the light reflection carriage such that the light scanning carriage and the light reflection carriage can be moved.

The apparatus may further include a guide shaft formed on the main body to guide the light scanning carriage and the light reflection carriage, installed on an end of each of the light scanning carriage and the light reflection carriage in the main scanning direction, and provided adjacent to the transport module.

The foregoing and/or other aspects and utilities of the present general inventive concept may also be achieved by providing an image reading apparatus, including a main body having a wire fixing portion, a first fixing pulley rotatably mounted on the main body, a second fixing pulley spaced-apart from the first fixing pulley and rotatably mounted on the main body, a light reflecting carriage movably disposed on the main body, and having a first carriage pulley rotatably mounted thereon and a second carriage pulley spaced-apart from the first carriage pulley and rotatably mounted thereon, a light scanning carriage movably disposed on the main body, and a wire wound around the first and second fixing pulleys and the first and second carriage pulleys having both ends coupled to the fixing portions of the main body and a portion fixedly coupled to the light scanning carriage.

BRIEF DESCRIPTION OF THE DRAWINGS

These and/or other aspects and advantages of the present general inventive concept will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings of which:

FIG. **1** is a perspective view illustrating an image reading apparatus according to an embodiment of the present general inventive concept;

FIG. **2** is a perspective view illustrating a pair of transport modules of the image reading apparatus of FIG. **1**;

FIG. **3** is a plan view illustrating the pair of transport modules of FIG. **2**;

FIG. **4** is a side view illustrating the pair of transport modules of FIG. **2**;

FIG. **5** is a side view illustrating distances between a first fixing pulley and a second fixing pulley and between a first carriage pulley and a second carriage pulley in the transport modules of FIG. **2**;

FIG. **6** is a side view illustrating the transport modules of FIG. **2** and guide rails of an image reading apparatus according to an embodiment of the present general inventive concept and the transport modules of FIG. **2**;

FIG. **7** is a side view illustrating a pair of transport modules and a guide shaft of an image reading apparatus according to an embodiment of the present general inventive concept;

FIG. **8** is a perspective view illustrating a transport module and a guide shaft in an image reading apparatus according to an embodiment of the present general inventive concept; and

FIG. **9** is a plan view illustrating the transport module and the guide shaft of FIG. **8**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference will now be made in detail to the embodiments of the present general inventive concept, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to the like elements throughout. The embodiments are described below in order to explain the present general inventive concept by referring to the figures.

FIG. **1** is a perspective view illustrating an image reading apparatus according to an embodiment of the present general inventive concept. Referring to FIG. **1**, the image reading apparatus is a flat-bed type image reading apparatus combined with a sheet-fed type image reading apparatus including an automatic document feeder (ADF) **10**. The image reading apparatus includes a main body **101**, first and second glass plates **50** and **51** disposed on the main body **101**, the ADF **10**, a light scanning carriage **200**, and a light reflection carriage **400**. Although not illustrated in FIG. **1**, a printing unit may be included in the main body **101** of the image reading apparatus. In FIG. **1**, a sub-scanning direction x is a direction in which the light scanning carriage **200** and the light reflection carriage **400** move to read an image. In addition, a main scanning direction y is a direction in which the light scanning carriage **200** and the light reflection carriage **400** read the entire image of a document P (see FIG. **4**) at one time.

The first glass plate **50** contacts the document P conveyed by the ADF **10**, and the second glass plate **51** contacts the statically laid document P. The first and second glass plates **50** and **51** are separated from each other. An operational status of the image reading apparatus is displayed and various controlling keys are disposed on a display panel **40**.

The document P loaded on a paper supplying board **20** is conveyed to the first glass plate **50** by the ADF **10**. The light scanning carriage **200** and the light reflection carriage **400** are located below the first glass plate **50** to read the image of the document P which is fed with respect to the first glass plate **50** by the ADF **10**. After the image is read, the document P is discharged to a paper discharge board **30**. A document guide member **70** is disposed between end portions of the first and second glass plates **50** and **51**. The document guide member **70** guides a front edge of the document P as the document P passes over the first glass plate **50** to the paper discharge board **30**.

The document P can be directly supplied to the apparatus without using the ADF **10** by being directly placed on an upper surface of the second glass plate **51**. The light scanning carriage **200** and the light reflection carriage **400** move in the sub-scanning direction x below the second glass plate **51** to read the image of the document P. The light scanning carriage **200** is disposed to move with respect to the light reflection carriage **400**. The light scanning carriage **200** scans light onto the document P while moving at a first velocity V, and the light reflection carriage **400** reflects light signals incident from the light scanning carriage **200** to an image sensor **500** (see FIG. **4**) while moving at a second velocity V/2.

When the light scanning carriage **200** and the light reflection carriage **400** are located below the first glass plate **50**, they read the image of the document P that is conveyed by the ADF **10**. When the light scanning carriage **200** and the light reflection carriage **400** move below the second glass plate **51**, they read the image of the document P that is statically laid. The light scanning carriage **200** and the light reflection carriage **400** are not limited to the above examples.

FIG. **2** is a perspective view illustrating a pair of transport modules **600** of the image reading apparatus of FIG. **1**. FIGS. **3** and **4** are a plan view and a side view, respectively, of the pair of transport modules **600** of FIG. **2**. Referring to FIGS. **2** through **4**, the light scanning carriage **200**, the light reflection carriage **400**, the image sensor **500**, and the pair of transport modules **600** are illustrated.

The document P is placed on the glass plate **51**. The light scanning carriage **200** includes a light source **210** and a mirror **220**. The light source **210** scans the light onto the document P. The light reflected by the document P contains image data of the document P, which is defined as a light signal. The light signal is reflected by the mirror **220** toward the light reflection carriage **400**.

The light reflection carriage **400** includes a plurality of mirrors **220** and reflects the light signal incident from the light scanning carriage **200** to the image sensor **500**.

The image sensor **500** is fixed to the main body **101** of the image reading apparatus. The image sensor **500** converts the light signal obtained by scanning the document P into an electric signal. The image sensor **500** can be a charge coupled device (CCD). The CCD can have a high resolution and a deep focal depth suitable for a large-sized image reading apparatus with high speed that can read documents on A3 paper and larger. Although not illustrated, the image sensor **500** further includes a lens unit to focus the light signal incident from the light reflection carriage **400** to the CCD sensor, and a control board to control the operation of the CCD sensor.

The pair of transport modules **600** are disposed at both ends of the light scanning carriage **200** and the light reflection carriage **400**. The transport modules **600** transport the light scanning carriage **200** and the light reflection carriage **400** along the sub-scanning direction x with a ratio of 2:1 between the first and second velocities V and V/2 of the light scanning carriage **200** and the light reflection carriage **400**. Each side of the pair of transport modules **600** includes a first fixing pulley **620***a* and a second fixing pulley **620***b*, a first carriage pulley **640***a* and a second carriage pulley **640***b*, and a wire **610**. Either one or both of the pair of transport modules may be connected to a driving source **670**. If one driving source **670** is included for the pair of transport modules **600**, the pair of transport modules can share a driving power through a driving shaft **660**.

Rotary shafts of the first and second fixing pulleys **620***a* and **620***b* may be fixed to the main body **101** of the image reading apparatus such that the first and second fixing pulleys **620***a* and **620***b* rotate about the rotary shaft mounted on the main body **101**, and the first and second fixing pulleys **620***a* and **620***b* are separated from each other by a predetermined distance in the sub-scanning direction x. In addition, rotary shafts of the first and second carriage pulleys **640***a* and **640***b* are fixed to a side of the light reflection carriage **400**, and are separated from each other by a predetermined distance. Both ends of the wire **610** are fixed to a wire fixing portion **650** formed on the main body **101**, and a part of the wire **610** is fixed to the side of the light scanning carriage **200** by a fixing member **250**. The wire **610** can be coupled to the fixing member **250** at one or more points between where the wire **610** is wound around the first and second fixing pulleys **620***a* and **620***b* and where the wire **610** is wound around the first and second carriage pulleys **640***a* and **640***b*. To realize this arrangement, first, an end of the wire **610** can be fixed to the wire fixing portion **650**, and then, the wire **610** can be sequentially wound around the first carriage pulley **640***a*, the second fixing pulley **620***b*, the first fixing pulley **620***a*, and the second carriage pulley **640***b*. Then, the other end of the wire **610** is fixed to the wire fixing portion **650**. Accordingly, the part of the wire **610** between the fixing member **250** is fixedly coupled to the part of the wire **610** between the first and second fixing pulleys **620***a* and **620***b* and the first and second carriage pulleys **640***a* and **640***b*. Since a single wire **610** is wound around the pulleys, the accuracy of the ratio of the transporting velocities of the carriages **200** and **400** can be guaranteed, and assembling processes of the apparatus can be simplified and the fabrication costs can be reduced.

The wire **610** moves along the sub-scanning direction x while under a strong tensile force in order to support the weights of the light scanning carriage **200** and the light reflection carriage **400**. The wire **610** is formed of a material having high tensile strength and low creep so as not to be deformed by the tensile force. In an embodiment of the present general inventive concept, the wires **610** support both sides of the light scanning carriage **200** and the light reflection carriage **400** along the main scanning direction y.

The two first fixing pulleys **620***a* or the two second fixing pulleys **620***b* are paired in the main scanning direction y and are connected on opposite sides of the driving shaft **660**. Either one of the two first fixing pulleys **620***a* or two second fixing pulleys **620***b* may be connected to the driving source **670**. A driving belt **672** is wound around a pulley **671** coupled to the driving source **670** and a pulley **673** coupled to the driving shaft **660**, and a rotational force of the driving source **670** is transferred to the driving shaft **660**. In the present embodiment, the pair of first fixing pulleys **620***a* disposed in the main scanning direction y is installed on the driving shaft **660**. The light scanning carriage **200** and the light reflection carriage **400** can be moved without vibration or deviation in their respective velocities V and V/2 by the first fixing pulleys **620***a* installed on the same driving shaft **660**.

When the wire **610** travels a distance H per unit time in the sub-scanning direction x direction, the first and second carriage pulleys **640***a* and **640***b* travel a distance H/2 per unit time due to the arrangement of pulleys. When an upper portion of the wire **610**, which is opposite to the fixing portions **650**, moves a distance H in the sub-scanning direction x direction, the first and second carriage pulleys **640***a* and **640***b* moves a length H/2. The light scanning carriage **200**, to which an upper portion of the wire **610** is fixed, moves a distance H per unit time, and the rotary shafts of the first and second carriage pulleys **640***a* and **640***b* and the light reflection carriage **400** move a distance H/2 per unit time, and thus, the ratio between the velocities V and V/2 of the light scanning carriage **200** and the light reflection carriage unit **400** is constant at 2:1. The first and second fixing pulleys **620***a* and **620***b* may have a diameter two times greater than that of the first and second carriage pulleys **640***a* and **640***b*.

FIG. **5** is a diagram illustrating a distance between the first and second fixing pulleys **620***a* and **620***b* and a distance between the first and second carriage pulleys **640***a* and **640***b* in the image reading apparatus of FIG. **2**. Reference character A illustrates a case in which the light scanning carriage **200** and the light reflection carriage **400** are closest to the first fixing pulley **620***a*. Reference character B illustrates a case in which the light scanning carriage **200** and the light reflection carriage **400** are closest to the second fixing pulley **620***b*.

Reference character L denotes a maximum distance the light scanning carriage **200** can travel in the sub-scanning direction x. Therefore, a maximum length of the document P that can be read by the image reading apparatus is the maximum distance L. When the light scanning carriage **200** moves by the maximum distance L, the first and second carriage pulleys **640***a* and **640***b* move the distance L/2 due to the arrangement of the pulleys, and the light reflection carriage **400** also moves the distance L/2. Reference character S**1** denotes a distance between the first and second carriage pulleys **640***a* and **640***b* in the sub-scanning direction x, and reference character S**2** denotes a distance between the first and second fixing pulleys **620***a* and **620***b*.

Since a portion of the wire **610** between the first and second carriage pulleys **640***a* and **640***b* is fixed to the light scanning carriage **200** by the fixing member **250**, the light scanning carriage **200** moves between the first and second carriage pulleys **640***a* and **640***b* while moving between the first and second fixing pulleys **620***a* and **620***b* together with the light reflection carriage **400**. Therefore, contact interference between the fixing member **250** and the first and second carriage pulleys **640***a* and **640***b* can be prevented.

The distance between the first and second carriage pulleys **640***a* and **640***b* may be greater than half of the distance L/2 that the light scanning carriage **200** can move in the sub-scanning direction x. That is, S**1** may be greater than L/2. As described above, when the light scanning carriage **200** moves a distance L, the first and second carriage pulleys **640***a* and **640***b* move the distance L/2 due to the arrangement of the pulleys. Therefore, S**1** the distance between the first and second carriage pulleys **640***a* and **640***b* can be greater than the distance L/2 in order to prevent the light scanning carriage **200** and the first and second carriage pulleys **640***a* and **640***b* from interfering with each other.

In addition, The distance S**2** between the first and second fixing pulleys **620***a* and **620***b* may be greater than the sum of half the distance L/2 the light scanning carriage **200** can move in the sub-scanning direction x and the distance S**1** between the first and second carriage pulleys **640***a* and **640***b*. That is, the distance S**2** can be greater than a sum of L/2 and S**1**. Therefore, the light reflection carriage **400** and the first and second fixing pulleys **620***a* and **620***b* do not interfere with each other.

In addition, the first and second carriage pulleys **640***a* and **640***b* may have smaller diameters than the first and second fixing pulleys **620***a* and **620***b*. Therefore, the path of the wire **610** supported by the first and second carriage pulleys **640***a* and **640***b* is inside the path of the wire **610** supported by the first and second fixing pulleys **620***a* and **620***b*. The entire wire **610** moves at the same speed, and when the paths of the wire **610** are separated as described above, contact between the wires **610** can be prevented.

FIG. **6** is a side view illustrating guide rails **720** and **740** of the transport modules **600** of the image reading apparatus according to another embodiment of the present general inventive concept. The guide rail **720** supports the light scanning carriage **200** and the guide rail **740** supports the light reflection carriage **400**. FIGS. **2** through **5** illustrate the light scanning carriage **200** and the light reflection carriage **400** each supported at both ends by the pair of transport modules **600**. However, in FIG. **6**, the pair of transport modules **600** and the guide rails **720** and **740** support the end portions of the light scanning carriage **200** and the light reflection carriage **400** and guide them. The guide rails **720** and **740** are formed on the main body **101** corresponding ones of the image reading apparatus. The guide rails **720** and **730** support at least one end of each of the light scanning carriage **200** and the light reflection carriage **400** along the main scanning direction y. According to the embodiment of FIGS. **2** through **5**, high tension is applied to the wire **610** to support the light scanning carriage **200** and the light reflection carriage **400**. However, when the guide rails **720** and **740** are included, the tension applied to the wire **610** can be reduced. When the tension applied to the wire **610** is reduced, radial loads applied to the fixing pulleys **620***a* and **620***b* and the carriage pulleys **640***a* and **640***b* can likewise be reduced, and thus, a durability of the apparatus can be increased and maintenance costs of the image reading apparatus can be reduced.

In the present embodiment, the wire **610** may pull the light scanning carriage **200** and the light reflection carriage **400** toward the guide rails **720** and **740** to contact the guide rails **720** and **740**. Contact with the guide rails **720** and **740** can be achieved by appropriately adjusting installation heights of the guide rails **720** and **740**. Therefore, the light scanning carriage **200** and the light reflection carriage **400** can be supported stably in the vertical direction z.

FIG. **7** is a side view illustrating a guide shaft **800** of the transport modules **600** of the image reading apparatus according to another embodiment of the present general inventive concept. Referring to FIG. **7**, the image reading apparatus includes the guide shaft **800** in addition to the pair of transport modules **600** to support the end portions of the light scanning carriage **200** and the light reflection carriage **400**. The guide shaft **800** is fixed to the main body **101** of the image reading apparatus, and extends in the sub-scanning direction x. The guide shaft **800** is inserted into the light scanning carriage **200** and the light reflection carriage **400** such that the light scanning carriage **200** and the light reflection carriage **400** can move along the guide shaft **800**. Although not illustrated in FIG. **7**, the light scanning carriage **200** and the light reflection carriage **400** include guide holes formed therein into which the guide shaft **800** is inserted. A sliding bearing (not shown) may also be disposed between the guide shaft **800** and the guide holes. When the guide shaft **800** is disposed at only one end of the light scanning carriage **200** and the light reflection carriage **400**, vibrations caused by the friction between the guide shaft **800** and the guide holes can be reduced. The vibration can be reduced, for example, because a zigzag movement of the light scanning carriage **200** and the light reflection carriage **400** along the sub-scanning direction x, due to an accumulation of gap tolerances in a plurality of the guide shafts **800** and the guide holes, is prevented.

FIGS. **8** and **9** are perspective and plan views illustrating the guide rail **740** and a guide shaft **800** of the transport module **600** according to another embodiment of the present general inventive concept. FIGS. **8** and **9** illustrate the light scanning carriage **200**, the light reflection carriage **400**, one of the transport modules **600**, and the guide shaft **800**.

The one transport module **600** is disposed at an end of the light scanning carriage **200** and the light reflection carriage **400**. The one transport module **600** and the guide shaft **800** support the weights of the light scanning carriage **200** and the light reflection carriage **400** and guide the light scanning carriage **200** and the light reflection carriage **400** to have an exact movement. The one transport module **600** is described in detail with reference to FIGS. **2** through **5**, and a detailed description of the transport module **600** will not be repeated.

The guide shaft **800** may be installed at an end of the light scanning carriage **200** and the light reflection carriage **400** adjacent to the one transport module **600**, and extend in the sub-scanning direction x. If the distance between the one transport module **600** and the guide shaft **800** in the main scanning direction y is reduced, a moment magnitude between the one transport module **600** and the guide shaft **800**

when moving the light scanning carriage **200** and the light reflection carriage **400** can be reduced, and the carriages **200** and **400** can move stably. The moment magnitude is the value of (the distance between the one transport module **600** and the guide shaft)×(the vibration force generated when the light scanning carriage **200** and the light reflection carriage **400** move in zigzag due to the gap tolerance of the guide shaft **800**). Thus, if the distance between the one transport module **600** and the guide shaft **800** is reduced, the moment magnitude is also reduced.

Referring to FIG. **9**, the image reading apparatus may further include the guide rails **720** and **740** to support portions of the light scanning carriage **200** and the light reflection carriage **400** which are apart from the guide shaft **800**. If the guide shaft **800** is installed adjacent to the one transport module **600**, the other ends of the light scanning carriage **200** and the light reflection carriage **400**, which are opposite to the guide shaft **800**, are free ends. When the distance between the one transport module **600** and the guide shaft **800** in the main scanning direction y is small, additional installation of a unit to support the free ends may be necessary. Therefore, the guide rails **720** and **740** are disposed on the main body **101** of the image reading apparatus to support the other ends of the light scanning carriage **200** and the light reflection carriage **400** and guide the movement of the light scanning carriage **200** and the light reflection carriage **400**.

As described above, the light scanning carriage and the light reflection carriage can move with a constant speed ratio therebetween, and thus, a defective image reading can be prevented. In addition, since pulleys installed on a transport module are wound with a same wire, assembling processes can be simplified and manufacturing costs can also be reduced.

Although a few embodiments of the present general inventive concept have been shown and described, it will be appreciated by those skilled in the art that changes may be made in these embodiments without departing from the principles and spirit of the general inventive concept, the scope of which is defined in the appended claims and their equivalents.

What is claimed is:

1. An image reading apparatus comprising:

a main body;

an image sensor fixed to the main body;

a light scanning carriage to scan light onto a document and to reflect a light signal corresponding to the scanned light after reading the document;

a light reflection carriage to reflect the light signal incident from the light scanning carriage to the image sensor; and

a pair of transport modules to move the light scanning carriage and the light reflection carriage in a sub-scanning direction with a speed ratio of 2:1, the pair of the transport modules comprising:

a first fixing pulley and a second fixing pulley connected to a driving source and separated from each other in the sub-scanning direction,

a first carriage pulley and a second carriage pulley disposed on the light reflection carriage between the first and second fixing pulleys, and

a wire having both ends fixed to the main body and having a portion fixed to the light scanning carriage, the wire being sequentially wound around the first carriage pulley, the second fixing pulley, the first fixing pulley, and the second carriage pulley.

2. The apparatus of claim **1**, wherein the first fixing pulley or the second fixing pulley are installed as a pair on a same driving shaft extending in a main scanning direction, and are connected to the driving source.

3. The apparatus of claim **2**, wherein the light scanning carriage moves between the first and second carriage pulleys.

4. The apparatus of claim **3**, wherein a distance between the first carriage pulley and the second carriage pulley is greater than a half of a distance that the light scanning carriage can move in the sub-scanning direction.

5. The apparatus of claim **4**, wherein a distance between the first fixing pulley and the second fixing pulley is greater than a sum of the half of the distance that the light scanning carriage can move in the sub-scanning direction and the distance between the first carriage pulley and the second carriage pulley.

6. The apparatus of claim **5**, wherein the first carriage pulley and the second carriage pulley have smaller diameters than diameters of the first and second fixing pulleys.

7. The apparatus of claim **1**, further comprising:

guide rails to support at least one end of each of the light scanning carriage and the light reflection carriage such that the light scanning carriage and the light reflection carriage can move.

8. The apparatus of claim **7**, wherein the wire pulls the light scanning carriage and the light reflection carriage toward the guide rails so that the light scanning carriage and the light reflection carriage contact the guide rails.

9. The apparatus of claim **1**, further comprising:

a guide shaft inserted into the light scanning carriage and the light reflection carriage such that the light scanning carriage and the light reflection carriage can be moved.

10. The apparatus of claim **1**, further comprising:

a guide shaft movably inserted into the light scanning carriage and the light reflection carriage and installed on an end of each of the light scanning carriage and the light reflection carriage in the main scanning direction, and provided adjacent to the transport module.

11. The apparatus of claim **10**, wherein the light scanning carriage moves between the first carriage pulley and the second carriage pulley.

12. The apparatus of claim **11**, wherein the distance between the first carriage pulley and the second carriage pulley is greater than a half of a distance that the light scanning carriage can move in the sub-scanning direction.

13. The apparatus of claim **12**, wherein the distance between the first fixing pulley and the second fixing pulley is greater than a sum of a half of the distance that the light scanning carriage can travel in the sub-scanning direction and the distance between the first carriage pulley and the second carriage pulley.

14. The apparatus of claim **13**, wherein the first carriage pulley and the second carriage pulley have smaller diameters than diameters of the first and second fixing pulleys.

15. The apparatus of claim **10**, further comprising:

guide rails to support one end between the both ends of each of the light scanning carriage and the light reflection carriage in the main scanning direction such that the light scanning carriage and the light reflection carriage can be moved, and the end supported by the guide rail is separated from the guide shaft.

16. An image reading apparatus, comprising:

a main body having a wire fixing portion;

a first fixing pulley rotatably mounted on the main body;

a second fixing pulley spaced-apart from the first fixing pulley and rotatably mounted on the main body;

a light reflecting carriage movably disposed on the main body, and having a first carriage pulley rotatably mounted thereon and a second carriage pulley spaced-apart from the first carriage pulley and rotatably mounted thereon;

a light scanning carriage movably disposed on the main body; and

a wire wound around the first and second fixing pulleys and the first and second carriage pulleys, and having both ends coupled to the fixing portions of the main body and a portion fixedly coupled to the light scanning carriage.

17. The image reading apparatus of claim **16**, wherein the wire is wound around the first carriage pulley, the second fixing pulley, the first fixing pulley, and the second carriage pulley in order.

18. The image reading apparatus of claim **16**, wherein the light scanning carriage comprises a fixing member disposed between the first and second carriage pulleys to be fixedly coupled to the portion of the wire.

19. The image reading apparatus of claim **16**, further comprising:

a power source to be connected to at least one of the first fixing pulley and the second fixing pulley.

20. The image reading apparatus of claim **16**, wherein the first and second carriages are disposed between the first and second fixing pulleys.

21. The image reading apparatus of claim **16**, wherein the portion of the wire is disposed opposite to the wire fixing portion with respect to a line connecting rotate axes of the first and second carriage pulleys.

22. The image reading apparatus of claim **16**, wherein a ratio of diameters of the first fixing pulley and the first carriage pulley is the same as a ratio of speeds of the light scanning carriage and the light reflecting carriage.

23. The image reading apparatus of claim **16**, wherein the wire fixing portion is spaced apart from the first fixing pulley by a distance less than a maximum moving distance of the light reflecting carriage.

24. The image reading apparatus of claim **16**, wherein the wire fixing portion is disposed between the first and second carriage pulleys.

25. The image reading apparatus of claim **16**, wherein the main body comprises a first guide member to guide a movement of the light reflecting carriage and a second guide member to guide a movement of the light scanning carriage.

26. An image reading apparatus comprising:

a main body;

a light reflection carriage moveable along a scanning axis in the main body;

a light scanning carriage coupled to the light reflection carriage to move along the scanning axis in the main body;

a first fixing pulley and a second fixing pulley rotatably coupled to the main body and separated from each other along the scanning axis;

a first carriage pulley and a second carriage pulley rotatably coupled to the light reflection carriage between the first and second fixing pulleys; and

a wire having both ends fixed to the main body and having a portion fixed to the light scanning carriage, the wire being sequentially wound around the first carriage pulley, the second fixing pulley, the first fixing pulley, and the second carriage pulley to move the first and second carriage pulleys along the scanning axis between the first and second fixing pulleys.

27. The image reading apparatus of claim **26**, further comprising:

a first fixing rotary shaft extending perpendicular to the scanning direction axis and coupled to the main body and the first fixing pulley to rotate the first fixing pulley in a direction of the scanning axis; and

a second fixing rotary shaft positioned opposite the first fixing rotary shaft along the scanning axis and extending perpendicular to the scanning axis and coupled to the main body and the first fixing pulley to rotate the first fixing pulley in a direction of the scanning axis.

28. The image reading apparatus of claim **27**, further comprising:

a first carriage rotary shaft extending perpendicular to the scanning axis and coupled to the light reflection carriage and the first carriage pulley to rotate the first carriage pulley in a direction of the scanning axis; and

a second carriage rotary shaft positioned opposite the first carriage rotary shaft along the scanning axis and extending perpendicular to the scanning axis and coupled to the light reflection carriage and the second carriage pulley to rotate the second carriage pulley in a direction of the scanning axis.

29. The image reading apparatus of claim **26**, wherein the wire forms an inner loop surrounding the first and second carriage pulleys and an outer loop surrounding the first and second fixing pulleys and the inner loop where the inner loop moves along the scanning axis between the outer loop in response to moving the light reflection carriage.

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